MONTHLY PROGRESS REPORT
MONTANA DOT "PERFORMANCE PREDICTION MODELS"
MAY 2004

To: **Susan Sillick, MDT; Jon Watson, MDT**
Contract No.: **MDT HWY-30604-DT**
Contractor: **Fugro Consultants LP**
Contract Period: **June 2001-May 2006**
Prepared By: **Jim Moulthrop, Project Manager**
Date Prepared: **June 8, 2004**

PROJECT OVERVIEW

The overall objective of this research is to develop a design process and performance/distress prediction models that will enable the Montana Department of Transportation (MDT) to use mechanistic-empirical principles for flexible pavement design. The project involves a comprehensive performance monitoring and laboratory-testing program and spans a period of five years.

The specific tasks identified in the work plan are:

PHASE I
- Task 1. Literature Review
- Task 2. Review of MDT Pavement-Related Data
- Task 3. Establish the Experimental Factorials
- Task 4. Develop Work Plan for Monitoring and Testing

PHASE II
- Task 5. Presentation of Work Plan to MDT
- Task 6. Implement Work Plan – Data Collection
- Task 7. Data Analyses and Calibration of Performance Prediction Models
- Task 8. Final Report and Presentation of Results

NOTE: New information each month will be notated by double-lines to the left of text, tables, or figures.

CURRENT WORK ACTIVITIES AND COMPLETED TASKS

PHASE I

Task 1 – Literature Review

Completed: The "Literature Review," summarizing the pavement performance models to be considered within this project, was submitted to MDT in October 2001.

Task 2 – Review of MDT Pavement-Related Data

Completed: A review of the available pavement-related data specific to the State of Montana was completed and included in the Task 3 "Experimental Factorial" and Task 4 "Sampling and Testing Plan" submitted to the MDT in October 2001.

Planned: Because the LTPP database is updated periodically, to ensure the data is accurate and current, Fugro will perform a one-time final update of the calibration/validation database before the end of the project.

Task 3 – Establish the Experimental Factorials

Completed: The "Minimum Data Elements" report and the "Experimental Factorial" were completed and submitted to MDT in October 2001. The factorial consists of 93 LTPP test sections of which 38 are in the State of Montana and the remaining 55 in neighboring States and Canada. In addition, 10 non-LTPP, supplemental sites were established and included in the factorial. These sites are: Condon, Deerlodge / Beckhill, Silver City, Roundup, Lavina, Wolf Point, Ft. Belknap, Perma, Geyser, and Hammond.

In March 2004, after a review of the results of the performance prediction analyses available to date, the team decided to include the two tentatively selected Superpave sites, Lothair and Baum Rd., in the group of non-LTPP sites. These sites were selected based on their geographical location and subgrade type in order to cover the whole range of climatic/subgrade conditions specific to Montana.

Task 4 – Develop Work Plan for Monitoring and Testing

Completed: A Work Plan was developed and provided to MDT in October 2001. The document contains the "Materials Sampling Plan," the "Initial Testing Plan" to document the baseline condition of each test site, the "Laboratory Testing Plan" to define the material properties and layer thickness at each test site, and the "Performance Monitoring Plan" to document time series data within the 60-month contract period.

The Performance Monitoring Plan was revised in a team meeting in March 2004 and is presented here:

- *Distress Surveys* Available: June 2002, June 2003; plan for June 2005
- *FWD* Available: August 2001, April 2002; plan for May 2004, March 2005
- *Profile* Available: October 2001; plan for May 2004, May 2005

This Month: A comparison study was performed on LTPP sections in Great Falls and Big Timber, Montana (May 6 – May 19) in which Montana LTPP sections were tested in parallel with MDT's FWD equipment and LTPP's FWD equipment. The purpose of this comparison testing is to identify any bias that might exist between the FWDs used to measure deflection data on different test sections that will be used on this project. The hypothesis is that there is no bias between the two devices. The testing will be completed and analyzed to confirm or reject that hypothesis. The data analysis should be completed within the next quarter.

Task 5 – Presentation of Work Plan to MDT

Completed: The Work Plan (PowerPoint) was presented to MDT by the project team in October 2001.

PHASE II

Task 6 – Implement Work Plan – Data Collection

LTTP SITES
There are 93 LTPP sites included in the experimental factorial. Of these, 38 are located in Montana and 55 in neighboring States and Canada. A set of queries was written that can be used at any time in the future to extract the data needed from the LTPP database to update the information in the calibration/validation database. The database is now complete and populated with LTPP data.

NON-LTPP SITES
The 10 non-LTPP sites are: Condon, Deerlodge / Beckhill, Silver City, Roundup, Lavina, Wolf Point, Ft. Belknap, Perma, Geyser, and Hammond. All testing related to the 10 sites is completed and the results have been presented in previous progress reports.

SUPERPAVE SITES
In addition to the 10 non-LTPP sites, two Superpave sites have been selected to be included in the testing/monitoring plan. These sites are Lothair and Baum Rd. Samples of materials from the two sites have been received from MDOT during 2003 and consist of binder cans, bags of bulk mix and buckets with unbound material. The materials have been stored off site in a temperature controlled storage room.

Binder testing results from Trumbull (Garnite City, Illinois) for the three Superpave mixtures tests became available this month and are presented in Table 1:

Table 1. Binder Tests on Superpave Mixes

		Penetration, 0.1 mm			Pen. Avg. 100g 5s	Absolute Viscosity Poise	Kinematic Viscosity cSt
Location	Sample #	1	2	3			
Ft Belknap NH1-7(32) 429	01	135	136	134	135	3608	885
	02	134	137	134	135	3877	922
Baum Rd NH8-4(22) 58	01	86	85	87	86	15700	1698
	02	83	85	86	85	17122	1672
Lothair NH1-5(5) 308	01	95	95	94	95	1956	520
	02	92	93	93	93	2030	485

NOTE: HMA cores are not available to test for indirect resilient modulus, tensile strength and creep. However, gradation, volumetric properties and viscosity can be used to predict the stiffness of the HMA layer using the "Witczak et al. Dynamic Modulus" predictive equation.

Task 7 – Data Analyses and Calibration of Performance Prediction Models

Completed: The calibration technique (or the specific steps required to determine calibration coefficients) was demonstrated to MDT utilizing models similar in nature to the NCHRP 1-37A Design Guide models. The project team made a presentation to the department in August 2003, which included a progress report, findings, and an illustration of the calibration exercise for the Silver City test section. A detailed discussion of the calibration algorithm accompanied by examples and step-by-step instructions will be included in a chapter of the Final Report.

The calibration and validation database has been finalized and populated with LTPP data. The calibration/validation database was sent to MDT (CD format) in January 2004. An initial "Database Schema" was provided to MDT in October 2001 from the review of the LTPP database (Release11.5). The "Database Schema" was updated in June 2003 (Release 16).

An initial performance prediction exercise was performed for the 10 non-LTPP experimental sites. Material test data together with historical traffic and climatic data were used to predict the performance of these sites in terms of fatigue cracking and rutting in the asphalt concrete layer and rutting in the base and subgrade layers. Predicted distress was compared to results of the two distress surveys available for these sites (June 2002 and June 2003) and to the rutting measurements taken in October 2001. The results of this exercise were included in the July-September 2003 Quarterly Report.

A second performance prediction analysis, similar to the one performed on the non-LTPP, was started on the LTPP experimental sites. The availability of LTPP data was investigated in parallel with this study. While the performance predictions could be done by either spreadsheets or using the 2002 Design Guide software, the solution by spreadsheets was used primarily because the Design Guide software is not yet available. However, after a review and revision of the project budget this month, the study was suspended. The team considers that the performance predictions that will be performed using the 2002 Design Guide software are of greater importance and the funds available will be allocated to this effort.

In addition, we request that MDT advise us as soon as the Mechanistic-Empirical Pavement Design Guide software is received. The project team prefers to use the software provided to MDT to ensure that consistent results are obtained over time.

Note that the calibration analyses performed so far do not specifically address the values of the calibration coefficients, but are limited to comparisons of predicted to measured distress using several widely used performance models (not necessarily the NCHRP 1-37A Design Guide models). Upon release of the NCHRP 1-37A Design Guide, the team will replace the current versions of the models with the Design Guide models and then proceed to the actual calibration of model coefficients. In addition, climatic/moisture data will be extracted from the Design Guide environmental database, which includes information for Montana and surrounding regions.

The project team will also complete a simplified calibration exercise using the same distress prediction models, but in a more simplified manner so that MDT can use this information with their pavement management database. This activity will be demonstrated to MDT during the final meeting and will be included in the final report submitted for review.

Task 8 – Final Report and Presentation of Results

No activity.

PROBLEMS / RECOMMENDED SOLUTIONS

No problems were encountered during last month and none are anticipated next month.

NEXT MONTH'S WORK PLAN

The activities planned for next month are listed below:

- Coordinate with MDT personnel on an as-needed basis.
- Continue populating the database with the data from non-LTPP sites.
- Retrieve and analyze FWD testing data from Great Falls and Big Timber, Montana.
- Schedule tentative meeting with MDT for August 2004. Release of the 2002 Design Guide is expected late June 2004.
- Continue testing of Lothair and Baum Rd materials

FINANCIAL STATUS

The Financial Summary I table shows the estimated expenses incurred during the reporting period.

The Financial Summary II table provides the total project expenditures by the Montana and FHWA fiscal years in comparison to the allocated funds for each fiscal year.

The Financial Summary III-A chart illustrates total expenditures from inception of the project June 2000 through December 2003. The Financial Summary III-B chart reflects total project expenditures from January 2004 to the end of the project, May 2006.

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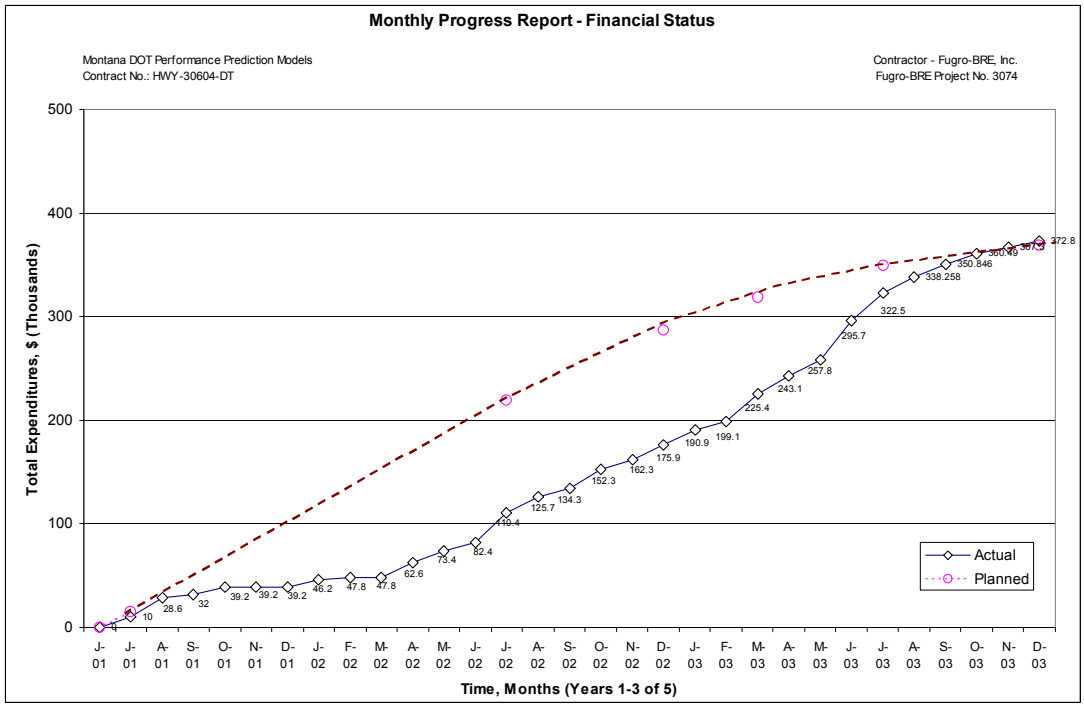
Financial Summary I
Estimated Expenses for Reporting Period: Fugro-BRE

Cost Element	Last Month's Cumulative Project Costs, $	Current Month's Expenditures, $	Cumulative Project Costs, $
Direct Labor	94,915	1,484	96,399
Overhead	135,729	2,122	137,851
Consultants/Subcontractors	4,050	0	4,050
ERES/ARA	26,953	2,521	29,474
Parsons-Brinckerhoff	12,093	0	12,093
SME	523	0	523
Dr. Matthew Witczak	0	0	2,850
Dr. Mark Hallenbeck	3,129	0	3,130
Travel	14,607	0	14,607
Testing	71,994	0	71,994
Other Direct Costs	6,614	33	6,647
Fee	37,061	364	37,425
TOTAL	407,670	6,524	414,193

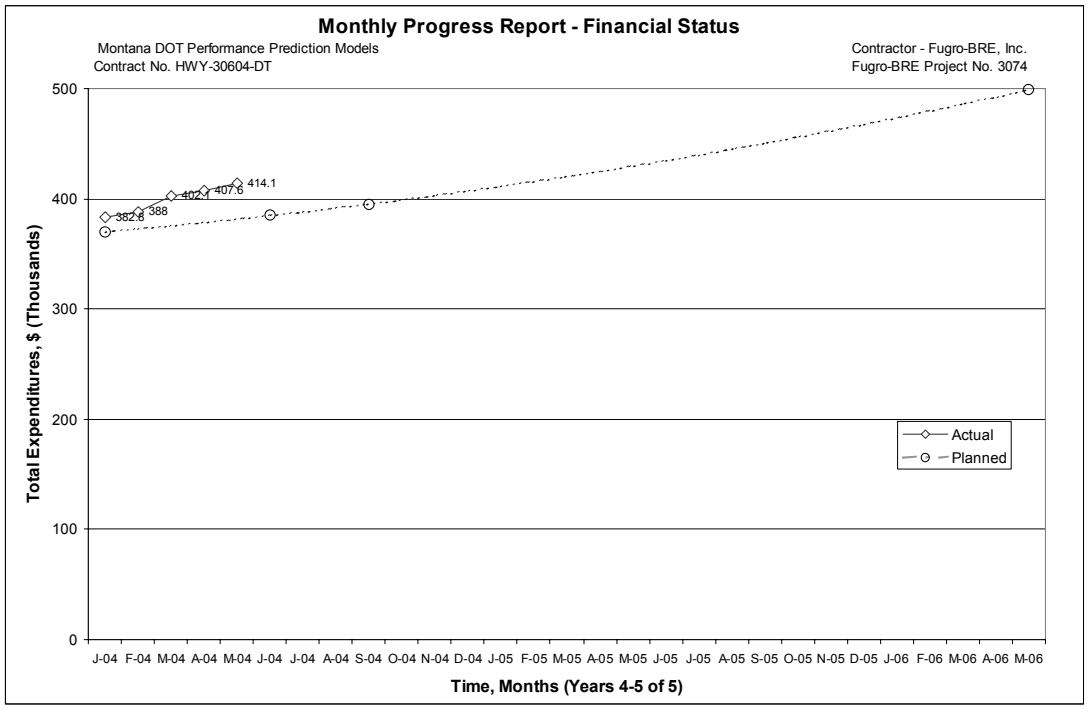
Financial Summary II
Total Expenditures by Fiscal Year: Montana and FHWA

MONTANA DOT FISCAL YEAR			**FHWA FISCAL YEAR**		
Fiscal Year	Cumulative Allocated Funds, $	Cumulative Expenditures, $	Fiscal Year	Cumulative Allocated Funds, $	Cumulative Expenditures, $
6/1/2000-6/30/**2001**	15,000	*0	6/1/2000-9/30/**2001**	65,000	31,996
7/1/2001-6/30/**2002**	218,969	82,420	10/1/2001-9/30/**2002**	258,969	102,303
7/1/2002-6/30/**2003**	348,969	213,291	10/1/2002-9/30/**2003**	358,969	216,187
7/1/2003-6/30/**2004**	388,969	118,483	10/1/2003-9/30/**2004**	398,969	63,708
7/1/2004-6/30/**2005**	428,969	---	10/1/2004-9/30/**2005**	438,969	---
7/1/2005-6/30/**2006**	498,969	---	10/1/2005-9/30/**2006**	498,969	---
TOTAL	498,969	414,193	TOTAL	498,969	414,194

*June 2001 expenditures were combined with July 2001 expenditures.



Financial Summary III-A: Total Expenditures by Month Jun 2000 – Dec 2003



Financial Summary III-B: Total Expenditures by Month Jan 2004 – May 2006